Increased Cases of Lung Injury Associated with the Use of Electronic Cigarettes Containing Nicotine and Flavoring

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Motivation for Research

Electronic cigarettes including all Electronic Nicotine Delivery Systems (ENDS) are the most common used tobacco product among middle, high schoolers and adults leading to addiction and health concerns.

- Some dominant health concerns among electronic cigarettes users are lung injury such as acute respiratory distress syndrome (ARDS), pulmonary fibrosis and chronic bronchitis.
- The use of e-cigarettes is still not regulated.
- Effect of nicotine and flavoring on airway epithelium remains unknown.

cdc.gov

Problem Statement

- This study aims to identify dominants respiratory illnesses affecting the lung and airways among electronic cigarette users, to learn what the world is doing about lung injury associated with the use of e-cigarette that affect young population worldwide, and to identify research gaps.
- While extensive research has revealed the addictive properties of nicotine, the effects of nicotine and flavoring compounds in electronic cigarettes on the respiratory system are still unclear. The health consequences of electronic cigarette use remains unclear.

Background and Significance

- In 2020, the FDA and CDC released findings in the national youth tobacco survey showing that 1.8 million fewer U.S. youths are currently using e-cigarettes compared to last years.
- Both the U.S. Food and Drug Administration and the U.S. Centers for Disease Control and Prevention are working to investigate the distressing incidents of severe respiratory illness related with the use of vaping products.
- The CDC recommend that individuals should avoid inhaling electronic cigarette or vaping products particularly with tetrahydrocannabinol (THC).

E-cigarettes Products Design

- Bioengineering and therapeutic sciences have developed a technique that mimics the function of an electronic cigarette vaping machine by reproducibly aerosolizing-e-liquids from e-cigarettes atomizers under controlled conditions.[8]
- This is useful for testing of nicotine and toxic compound formation and delivery.[8]

Mortality and Morbidity

- As of February 18, 2020, CDC reported a total of 2,807 **hospitalized** e-cigarette or vaping product use-associated lung injury **cases or deaths** from all 50 states, the District of Columbia, and two U.S. territories (Puerto Rico and U.S. Virgin Islands).[18]

Research Questions

- what does the effect of Electronic Nicotine Delivery System use do on airway epithelium
- what are the problems arising now that didn't exist before?
- what does flavor components do on airway?

Research Strategy

- A systematic review of scientific journals from PubMed, Food and Drug Administration (FDA) and Center for Disease Control and Prevention (CDC) with title search for "electronic cigarette" OR "e-cigarette" OR "electronic nicotine delivery system" published between 2012 to 2020 as well as "e-cigarette and bioengineering."
- Secondary data was used from the CDC and FDA reports to create a demographic table and biological reports table.
- Microsoft Excel (2019) was used to plot demographic parameters versus biological parameters to determine the trigger between behavior and the biology.
- This study assessed health respiratory illnesses associated with the use of electronic cigarettes or vaping products.

Results

Demographic Reports of E-cigarettes

Factors	2019 Ever used	Current	2018 Ever used	Current	2014 Ever used	Current
Gender						
Male	35.7	20.1	17.8	4.3	14.2	4.1
Female	34.5	20.1	20.1	2.3	11.2	3.4
Age						
18-24	-	-	25.8	7.6	21.6	5.1
25-44	-	-	21.1	4.3	16.6	4.7
45-64	-	-	11.0	2.1	10.2	3.5
65-over	-	-	4.7	0.8	3.7	1.4
Ethnicity						
White	38.2	23.3	16.9	3.7	14.8	4.6
Black	27.0	13.6	10.0	1.6	7.1	4.6
Hispanic	35.4	18.6	11.5	2.5	8.6	1.8
Asian	-	-	10.2	2.2	6.2	2.1
Education						
<middle school	19.9	10.5	2.5	4.9	10.1	3.9
High school	46.9	27.5	2.7	20.8	27.3	3.7

Table above shows there is a rise in e-cigarettes consumption among ever used in 2019.

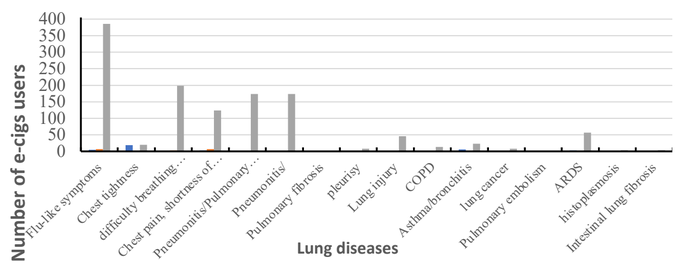
Biological Reports of E-Cigarettes Use

Health Factors	2019	2018	2017
Lung diseases			
Pneumonitis, pulmonary fibrosis	173	-	-
Pleurisy	8	-	-
Lung injury	46	-	-
COPD	13	-	-
Asthma, bronchitis	23	-	6
Lung cancer	8	-	-
Pulmonary embolism	1	-	-
ARDS	57	-	2
Histoplasmosis	4	-	-
Intestinal lung fibrosis	4	-	-

Health Factors	2019	2018	2017
Symptoms & Risk factor			
Flu-like symptoms	386	7	5
Chest tightness	20	-	19
Difficult breathing choking, low pulse rate	198	3	1
Chest pain, shortness of breath	124	7	2
Seizure	1004	6	-

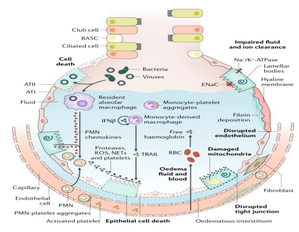
- Dominant lung diseases are ARDS, pulmonary fibrosis, bronchitis.[26]

A Visual Analysis of Dominant Pathologies Related to E-Cigarette Smoking



Nicotine & Smoking Associated with ARDS, Lung Fibrosis

- Chronic smoking is known to increase risk for acute respiratory distress syndrome (ARDS), a well-known chemicals that causes ARDS is **nicotine**[3]
- Nicotine modulate fibrosis by altering the functions of fibroblasts, it promotes both epithelial and endothelial cell damage leading to the activation of fibrogenesis[6].
- Recruitment of inflammatory cells by inhaling nicotine is a key event leading to fibrosis and a pathogenic result of acute and chronic tissue injury[6]



Damage Alveolus

Recommendation & Conclusion

- Results shown in this this project strongly demonstrate that pulmonary fibrosis and respiratory distress syndrome ARDS are dominant respiratory diseases that arise from the use of e-cigarette among youths.
- Smoking has a major impact on health issues worldwide, it play a harmful rather than beneficial.
- Education, prevention, therapy and counseling should be recommended for kids and youth in order to reduce the outbreaks of lung injury.
- Based on the analysis of secondary data, I recommend creating a cloud-based monitoring device that has sensors, to monitor and specifically detects electronic cigarette. This should be installed with app to a cloud-based monitoring platforms and it should be place in common places such as bathrooms, locker rooms, stores, classroom.

Future Bioengineering Development

- Development and validation of a novel multi-sensory wearable system (Personal Automatic Cigarette Tracker v2 or PACT2.0) was designed for monitoring of cigarette smoking and other smoking related features
- Focusing on sensing elements, body placement, detection accuracy underlying algorithms and application
- Development of an in vitro pre-malignancy model using metabolically competent immortalized human bronchial epithelial cells extended to three oral epithelial cell lines.[13]
- This is useful for testing acute and chronic effects of exposure to electronic cigarette (E-cig) aerosols containing nicotine and common classes of flavor chemicals.[13]

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